Making the Most of Your Manure Nutrients
Virtual Dairy Day 2021

Brian Dougherty
Field Agricultural Engineer - ISU Extension and Outreach
brian1@iastate.edu  @IAFieldAgEngrs
Overview

• Dairy manure economics and nutrient management
• Making manure and cover crops work together
• Northeast Research and Demonstration Farm data
  – Water quality
  – Cover crop N uptake
  – Nitrification inhibitor
  – Manure timing
  – Yields
Nutrient value of dairy manure

Fertilizer prices:
- Ammonia: $0.30/lb N
- MAP: $0.43/lb P$_2$O$_5$
- Potash: $0.28/lb K$_2$O

Typical dairy slurry manure:
- 10-25-40 pounds N, P$_2$O$_5$, K$_2$O per 1000 gallons
- 10 x $0.30 = $3
- 25 x $0.43 = $11
- 40 x $0.28 = $11
- Total = ~$25 per 1000 gallons

Additional value in organic matter and micronutrients
Nutrient availability from dairy manure

Dairy manure 30 to 50% crop available year 1, 10% year 2, 5% year 3

<table>
<thead>
<tr>
<th>Manure Source</th>
<th>Nitrogen</th>
<th>Phosphorus</th>
<th>Potassium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef cattle (solid or liquid)</td>
<td>30–40</td>
<td>60–100</td>
<td>90–100</td>
</tr>
<tr>
<td>Dairy (solid or liquid)</td>
<td>30–40</td>
<td>60–100</td>
<td>90–100</td>
</tr>
<tr>
<td>Liquid swine (anaerobic pit)</td>
<td>90–100</td>
<td>90–100</td>
<td>90–100</td>
</tr>
<tr>
<td>Liquid swine (anaerobic lagoon)</td>
<td>90–100³</td>
<td>90–100³</td>
<td>90–100</td>
</tr>
<tr>
<td>Poultry (all species)</td>
<td>50–60</td>
<td>90–100</td>
<td>90–100</td>
</tr>
</tbody>
</table>

Table from PMR 1003 Using Manure Nutrients for Crop Production.
Making the most of your manure nutrients

1. Reduce pathways for nutrient loss
   • Denitrification: nitrate (NO$_3^-$) to N$_2$ gas
   • Volatilization: ammonium (NH$_4^+$) to ammonia gas (NH$_3$)
   • Leaching: nitrate-N/dissolved P loss to drain tile or groundwater
   • Surface runoff: direct runoff or attached to soil particles

2. Apply manure at a consistent rate at the right time
   • Calibrate and maintain equipment
   • Avoid early fall application and/or plant a cover crop

3. Recoup your investment - you already paid for the manure
   • Don’t overapply N – take credit for legumes, sidedress if needed
   • Apply to low P soils – you can justify hauling further
### Table 2. Correction factors to account for N volatilization losses during and after land application of animal manure

<table>
<thead>
<tr>
<th>Application Method</th>
<th>Incorporation</th>
<th>Volatilization Correction Factor&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct injection</td>
<td>—</td>
<td>0.98–1.00</td>
</tr>
<tr>
<td>Broadcast (liquid/solid)</td>
<td>Immediate incorporation</td>
<td>0.95–0.99</td>
</tr>
<tr>
<td>Broadcast (liquid)</td>
<td>No incorporation</td>
<td>0.75–0.90</td>
</tr>
<tr>
<td>Broadcast (solid)</td>
<td>No incorporation</td>
<td>0.70–0.85</td>
</tr>
<tr>
<td>Irrigation</td>
<td>No incorporation</td>
<td>0.60–0.75</td>
</tr>
</tbody>
</table>

Table from PMR 1003 Using Manure Nutrients for Crop Production.
Make the most of your manure nitrogen

- Inject or incorporate immediately.
- Focus on application timing – the closer to crop demand the better.
- Use cover crops to help plug the leaks.
Make the most of your manure phosphorus

Crop uptake

- Inject or incorporate immediately (snowmelt runoff can be high P).
- Prioritize application to low-testing soils (< 20 ppm Bray-1/Mehlich 3)
- Reduce erosion and surface runoff – use low disturbance injectors.
Calibrate and maintain equipment

Effect of hose loops and plugged vents

Plugged vents

Photo credits: Kapil Arora, ISU Extension Field Ag Engineer
Manure and cover crops
Top 18? reasons to use a cover crop

1. Reduce erosion
2. Reduce compaction
3. Provide weed control
4. Increase soil organic matter
5. Increase infiltration rate
6. Prevent nutrient leaching
7. Recycle nutrients
8. Improve water quality
9. Increase soil water holding capacity
10. Feed soil biology
11. Provide grazing opportunities
12. Help with manure management
13. Reduce nutrient stratification?
14. Synchronize N availability/demand?
15. Cut fertilizer costs?
16. Improve yield potential?
17. Improve profitability?
18. Make you famous on Twitter??
Manure & cover crops work together

Capture & recycle nutrients
Reduce N loss

Residue decomposition
N availability

Soil
- Organic matter
- Porosity
- Nutrient cycling
- Infiltration
- Water holding capacity
- Aggregate stability
- Bulk density

Erosion control
Weed control
Grazing/forage

Add macro & micronutrients

Cover crops
Manure
Cover crops can provide additional manure application opportunities

Cropping activity windows for different crops in Iowa. Figure courtesy Dr. Dan Andersen.
Options for cover crops with manure

1. Seed cover after fall harvest and/or manure application.
2. Seed cover early into standing crop and apply manure later.
3. Slurry seed: mix cover crop seed into manure tank (need tank agitation) or direct inject seed into dragline hose.
4. Spread solid manure (thin layer) on growing cover crop.
5. Sidedress manure and seed cover crop in one pass.
Injecting manure into growing cover crops

Cover crop survival depends on how aggressive the injectors are.

Success with manure & cover crops

 ✓ Treat manure like fertilizer and cover crop like a cash crop
 ✓ Test soil and manure
 ✓ Consistency - manure, soil, and cover crop
 ✓ Proper equipment setup (application uniformity, depth)
 ✓ Follow soil health principles (↓disturbance, ↑soil armor)
 ✓ Start with ‘easy’ acres, simple mixes, and seed early
 ✓ Watch C:N ratios in manure and cover crop
Cover crop management - Nashua

- Early fall liquid swine manure injected at 150 lb N/ac.
- Cereal rye drilled at 80 lb/ac after manure application.
- Terminated with glyphosate
  - ~10-14 days before corn, ~+/- 2 days soybeans
Nashua cumulative nitrate-N drainage losses 2016 - 2020

Research funded by Iowa Pork Producers Association and Calcium Products Inc.
Nashua cumulative nitrate-N drainage losses 2016 - 2020

Research funded by Iowa Pork Producers Association and Calcium Products Inc.
Manure injection effect on cover crop

Rye cover crop growth with visible streaking at NERF April 6, 2016
Nashua cereal rye cover crop N uptake

Research funded by Iowa Pork Producers Association and Calcium Products Inc.
Nashua cereal rye cover crop N uptake

Effect of application timing

Early fall swine manure trail

<table>
<thead>
<tr>
<th>Years</th>
<th>N uptake (lb/ac) prior to corn 150 lb N/ac from manure</th>
<th>N uptake (lb/ac) prior to soybeans (no manure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016-2019</td>
<td>88</td>
<td>61</td>
</tr>
</tbody>
</table>

Spring UAN sidedress trial

<table>
<thead>
<tr>
<th>Years</th>
<th>N uptake (lb/ac) prior to corn 150 lb N/ac from UAN</th>
<th>N uptake (lb/ac) prior to soybeans (no UAN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008-2015</td>
<td>21</td>
<td>13</td>
</tr>
</tbody>
</table>
Cover crop effect on corn phase yields

Research funded by Iowa Pork Producers Association and Calcium Products Inc.
Manure timing effect on corn phase yields

Research funded by Iowa Pork Producers Association and Calcium Products Inc.
Manure timing effect on corn phase yields

Research funded by Iowa Pork Producers Association and Calcium Products Inc.
Manure timing effect on continuous corn yields

Research funded by Iowa Pork Producers Association and Calcium Products Inc.
# Economics of manure application timing

Assuming $3.50/bu corn:

<table>
<thead>
<tr>
<th>Location</th>
<th>Years</th>
<th>Type</th>
<th>Rotation</th>
<th>Application timing</th>
<th>Δ Yield</th>
<th>$/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nashua, IA</td>
<td>2016-2018 2020</td>
<td>Swine</td>
<td>Corn-soybean</td>
<td>Early fall → Late fall</td>
<td>+38 bu/ac</td>
<td>$133</td>
</tr>
<tr>
<td>Nashua, IA</td>
<td>2019</td>
<td>Swine</td>
<td>Corn-soybean</td>
<td>Late fall → Spring</td>
<td>+18 bu/ac</td>
<td>$63</td>
</tr>
<tr>
<td>Nashua, IA</td>
<td>2016-2018 2020</td>
<td>Swine</td>
<td>Continuous corn</td>
<td>Late fall → Spring</td>
<td>+28 bu/ac</td>
<td>$98</td>
</tr>
<tr>
<td>Ames, IA</td>
<td>2011-2013</td>
<td>Swine</td>
<td>Corn-soybean</td>
<td>Early fall → Late fall</td>
<td>+10 bu/ac</td>
<td>$35</td>
</tr>
<tr>
<td>Waseca, MN</td>
<td>2011-2014</td>
<td>Swine</td>
<td>Corn-soybean</td>
<td>Early fall → Late fall</td>
<td>+15 bu/ac</td>
<td>$53</td>
</tr>
<tr>
<td>Waseca, MN</td>
<td>2010-2011</td>
<td>Swine</td>
<td>Corn-soybean</td>
<td>Early fall → Late fall</td>
<td>+10 bu/ac</td>
<td>$35</td>
</tr>
<tr>
<td><strong>Average of 13 site-years</strong></td>
<td></td>
<td></td>
<td></td>
<td>Early fall → Late fall</td>
<td>+20 bu/ac</td>
<td>$70</td>
</tr>
<tr>
<td><strong>Average of 5 site-years</strong></td>
<td></td>
<td></td>
<td></td>
<td>Late fall → Spring</td>
<td>+26 bu/ac</td>
<td>$91</td>
</tr>
</tbody>
</table>
Nitrification inhibitor effect on cont. corn yields

Research funded by Iowa Pork Producers Association and Calcium Products Inc.

- Fall Instinct +12 bu/ac
- Fall Instinct +20 bu/ac
- Fall Instinct +0 bu/ac
- Fall Instinct +5 bu/ac
## Economics of manure + Instinct

Instinct cost ~$10+/acre depending on application rate  
**Corn = $3.50/bu**

<table>
<thead>
<tr>
<th>Location</th>
<th>Years</th>
<th>Type</th>
<th>Rotation</th>
<th>Application timing</th>
<th>Δ Yield, bu/ac</th>
<th>$/ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nashua, IA</td>
<td>2017-2018</td>
<td>Swine</td>
<td>Corn-soybean</td>
<td>Late fall + Instinct 70 oz.</td>
<td>+12</td>
<td>$42</td>
</tr>
<tr>
<td></td>
<td>2020</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waseca, MN</td>
<td>2011-2014</td>
<td>Swine</td>
<td>Corn-soybean</td>
<td>Early fall + Instinct 35 oz.</td>
<td>+12</td>
<td>$42</td>
</tr>
<tr>
<td></td>
<td>2011-2014</td>
<td>Swine</td>
<td>Corn-soybean</td>
<td>Early fall + Instinct 70 oz.</td>
<td>+17</td>
<td>$60</td>
</tr>
<tr>
<td></td>
<td>2011-2014</td>
<td>Swine</td>
<td>Corn-soybean</td>
<td>Late fall + Instinct 35 oz.</td>
<td>+3*</td>
<td>$11</td>
</tr>
<tr>
<td></td>
<td>2011-2014</td>
<td>Swine</td>
<td>Corn-soybean</td>
<td>Late fall + Instinct 70 oz.</td>
<td>+4*</td>
<td>$14</td>
</tr>
<tr>
<td></td>
<td>2010-2012</td>
<td>Swine</td>
<td>Corn-soybean</td>
<td>Early fall + Instinct 35 oz.</td>
<td>+13*</td>
<td>$46</td>
</tr>
<tr>
<td></td>
<td>2010-2012</td>
<td>Swine</td>
<td>Corn-soybean</td>
<td>Early fall + Instinct 70 oz.</td>
<td>+8 *</td>
<td>$28</td>
</tr>
<tr>
<td></td>
<td>2010-2012</td>
<td>Swine</td>
<td>Corn-soybean</td>
<td>Late fall + Instinct 35 oz.</td>
<td>+2 *</td>
<td>$7</td>
</tr>
<tr>
<td></td>
<td>2010-2012</td>
<td>Swine</td>
<td>Corn-soybean</td>
<td>Late fall + Instinct 70 oz.</td>
<td>-3 *</td>
<td>-$11</td>
</tr>
</tbody>
</table>

*Difference was not statistically significant at $P \leq 0.05$
Making the most of your manure nutrients

• Manage manure like fertilizer and cover crop like cash crop.
• Calibrate and maintain equipment for consistent application.
• **Reduce pathways for nutrient loss.**
  – *Wait to apply fall manure* until soils are below 50°F.
  – *Plant a cover crop* to reduce erosion and nutrient loss.
  – A cover crop after corn silage is a must.
  – Consider low-disturbance injection system.
  – Delay manure application timing if possible.
Questions?

Brian Dougherty
Field Agricultural Engineer
ISU Extension & Outreach
brian1@iastate.edu
563-239-7070
@IAFieldAgEngrs

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